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NEUTRON-EXPOSURE PARAMETERS FOR THE FOURTH HSST SERIES
OF METALLURGICAL IRRADIATION CAPSULES*

F. B. K. Kam, F. W. Stallmann, C. A. Baldwin, and A. Fabry†

Oak Ridge National Laboratory
Oak Ridge, Tennessee 37830

†CEN/SCK, Mol, Belgium

MASTER

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NEUTRON EXPOSURE PARAMETERS FOR THE FOURTH HSST SERIES
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ABSTRACT

The neutron exposure parameters for the Heavy Section Steel Technology (HSST) Experiments performed at the Oak Ridge National Laboratory (ORNL) can be determined conservatively to $\pm 10\%$ (1σ) variance.

The neutron exposure parameters used for this study were fluence greater than 1 MeV, fluence greater than 0.1 MeV, and displacements per atom (dpa). Measured reaction rates, calculated neutron transport fluxes, and cross sections values were combined in the logarithmic least square adjustment code LSL.⁽¹⁾

1. Introduction

The U.S. Nuclear Regulatory Commission (NRC) is conducting an extensive research program^(2,3) to study fracture toughness of irradiated pressure vessel materials in the upper transition region and to investigate the applicability of small specimen test results to thick-section materials. This study has been extended to the study of upper-shelf behavior (plastic behavior). The first three irradiation experiments (nine capsules) contained fracture toughness specimens of four-inch (4T-CS) and a number of smaller specimens of low-shelf weldments.

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The fourth HSST irradiation series (four capsules) is primarily designed to obtain statistical data on the fracture toughness of "current practice" weldments. Each of the capsules contains one-inch-thick fracture toughness (1T-CS), Charpy V-notch, and tension test specimens (Figs. 1 and 2).

In support of the material irradiation experiments, a neutron characterization program was initiated to provide accurate exposure parameters for correlation with the property change rate data. The dosimetry results of the second and third HSST series have been reported in Refs. 4 and 5. The experience gained in these two experiments have led to modifications in the composition and distribution of the dosimeters which monitor the flux spectrum in the irradiated steel specimens. In addition, multiple foil sets were irradiated in simulated HSST irradiation capsules to obtain detailed neutron spectrum information. This dosimetry experiment was a joint effort between CEN/SCK, Mol, Belgium and ORNL. The methods and techniques of measurement, calculation, and analysis are the same as applied to the neutron spectral characterization of the PCA experiments and Blind Test.⁽⁶⁾

2. Results

The results reported in this paper are for capsules A and B of the fourth HSST irradiation series (Fig. 3). Tables 1 and 2 show the exposure parameters (fluence > 1 MeV, fluence > 0.1 MeV and dpa) for each specimen in capsule A. For the 1T-CT specimens, the exposure values represent values at the crack tip. For the charpy specimens, the values are given at the apex of the v-notch. Similarly Tables 3 and 4 represent the exposure values for capsule B. A 3-dimensional map for the exposure parameters has been determined. This map has the form

$$\phi(x,y,z) = \phi_0 \cos B_x (x-x_0) \cos B_y (y-y_0) e^{-\lambda z} \quad (1)$$

Preliminary estimates yield a $\pm 10\%$ (1σ) variance for the exposure parameters obtained from equation (1).

A technical report will be issued at a later date with a detailed uncertainty analysis and the methodology that was used to arrive at the

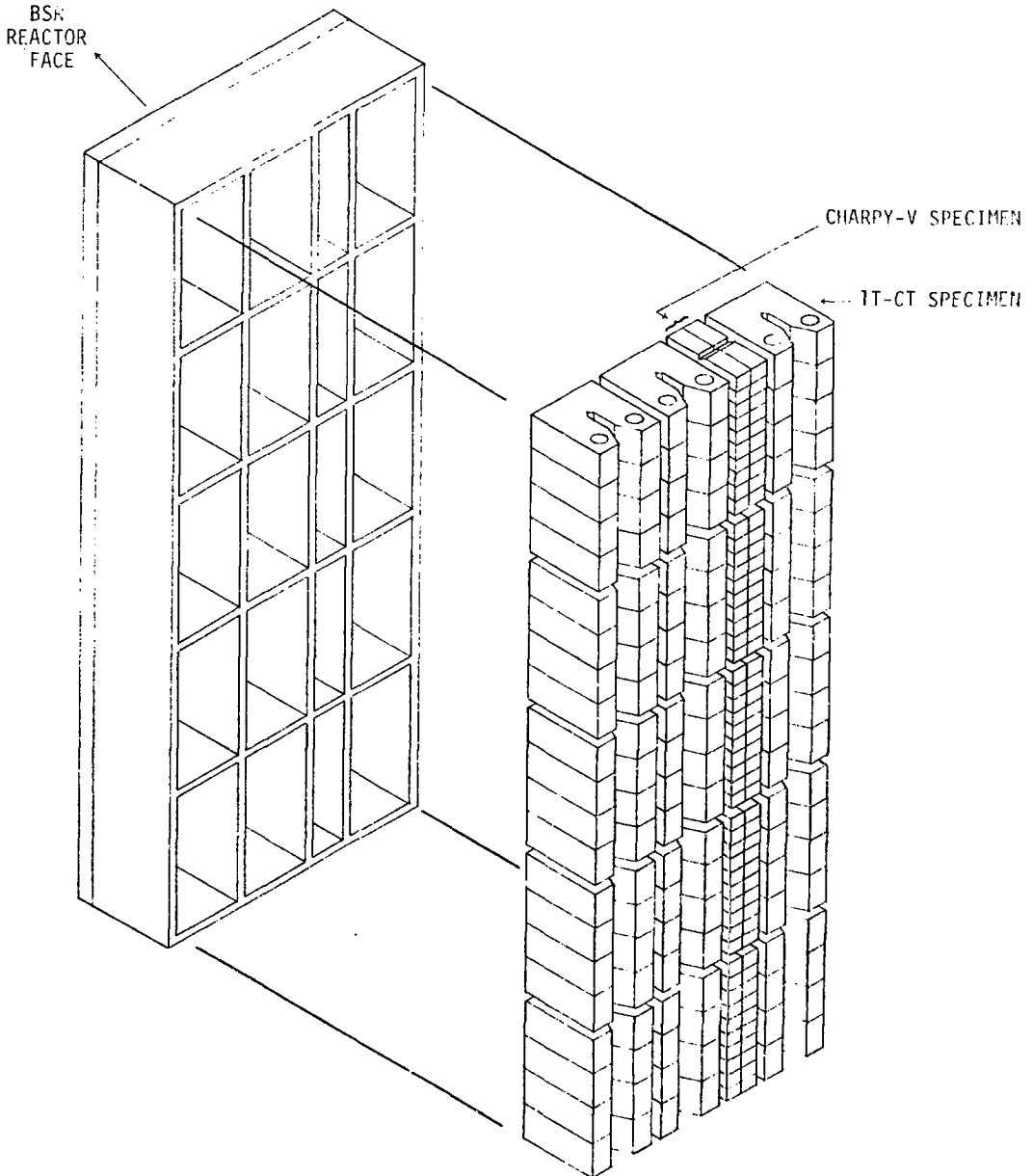


Fig. 1. Fourth HSS7 Series of Irradiation Capsules

1	21	41	42	141
		43	44	
		45	46	
2	22	47	48	142
		49	50	
		51	52	
3	23	53	54	143
		55	56	
		57	58	
4	24	59	60	144
		61	62	
		63	64	
5	25	65	66	145
		67	68	
		69	70	
6	26	71	72	146
		73	74	
		75	76	
7	27	77	78	147
		79	80	
		81	82	
8	28	83	84	148
		85	86	
		87	88	
9	29	89	90	149
		91	92	
		93	94	
10	30	95	96	150
		97	98	
		99	100	
11	31	101	102	151
		103	104	
		105	106	
12	32	107	108	152
		109	110	
		111	112	
13	33	113	114	153
		115	116	
		117	118	
14	34	119	120	154
		121	122	
		123	124	
15	35	125	126	155
		127	128	
		129	130	
16	36	131	132	156
		133	134	
		135	136	
17	37	137	138	157
		139	140	
18	38			158
19	39			159
20	40			160

Fig. 2. Specimen Position Numbers for Fourth HSST Series Irradiation Capsules.

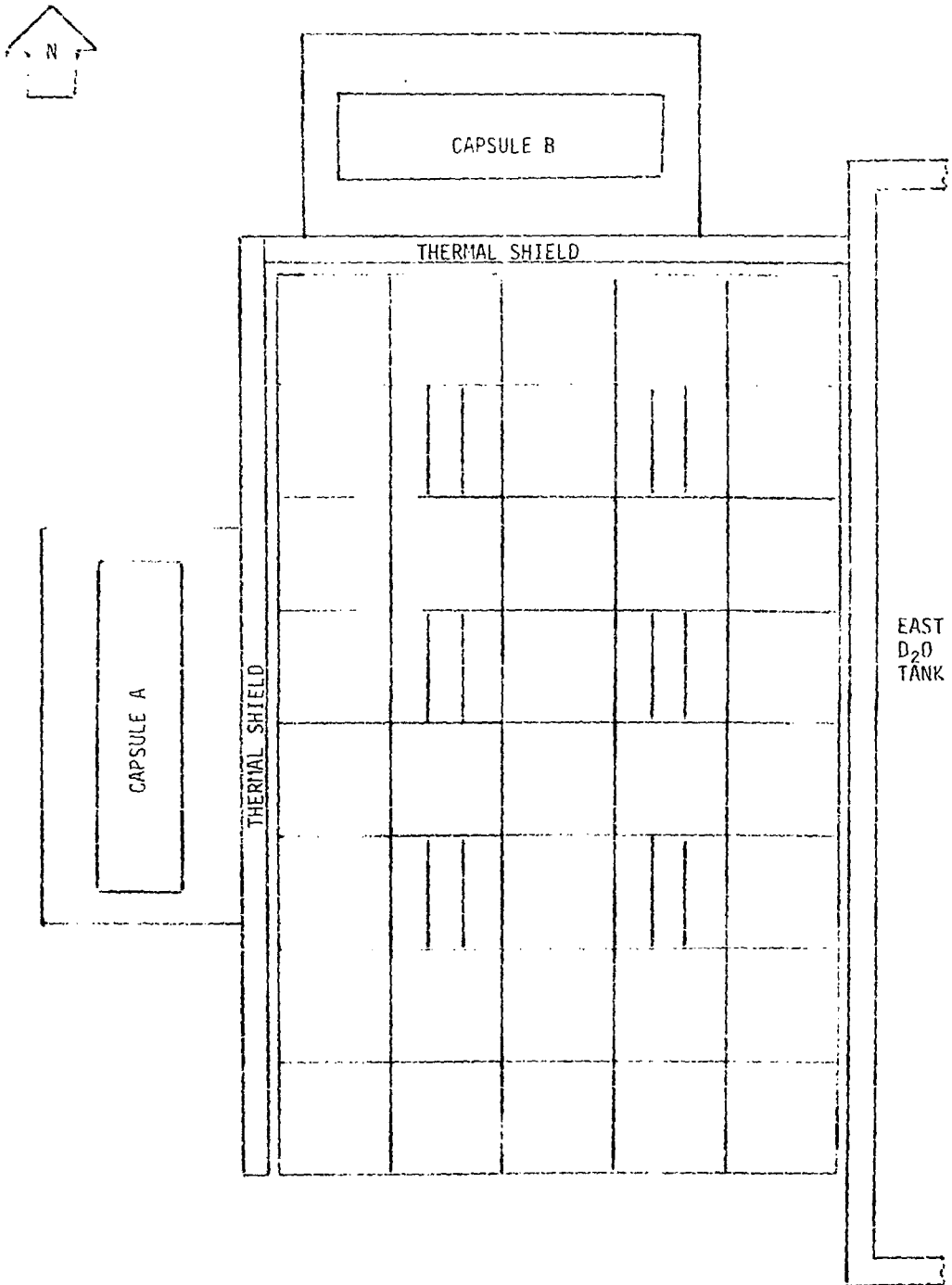


Fig. 3. Fourth HSST Experimental Configuration.

Table 1. Exposure Parameters for Capsule A IT-CT Specimens

Specimen Position No.	Fluence >1 MeV	Fluence >.1 MeV	DPA	Specimen Position No.	Fluence >1 MeV	Fluence >.1 MeV	DPA	Specimen Position No.	Fluence >1 MeV	Fluence >.1 MeV	DPA
1	7.9485E+18	2.6420E+19	1.2545E-02	21	1.0480E+19	3.6404E+19	1.6890E-02	141	8.8131E+18	3.0132E+19	1.4112E-02
2	1.0668E+19	3.5955E+19	1.6933E-02	22	1.3109E+19	4.6066E+19	2.1232E-02	142	1.0917E+19	3.7778E+19	1.7570E-02
3	1.3254E+19	4.5022E+19	2.1107E-02	23	1.5589E+19	5.5174E+19	2.1232E-02	143	1.2899E+19	4.4977E+19	2.0826E-02
4	1.5676E+19	5.3500E+19	2.5012E-02	24	1.7891E+19	6.3618E+19	2.9125E-02	144	1.4737E+19	5.1645E+19	2.3842E-02
5	1.8467E+19	6.3250E+19	2.9508E-02	25	2.0517E+19	7.3227E+19	3.3452E-02	145	1.6830E+19	5.9224E+19	2.7275E-02
6	2.0406E+19	7.0000E+19	3.2627E-02	26	2.2321E+19	7.9801E+19	3.6419E-02	146	1.8266E+19	6.4404E+19	2.9626E-02
7	2.2092E+19	7.5836E+19	3.5331E-02	27	2.3871E+19	8.5414E+19	3.8960E-02	147	1.9497E+19	6.8822E+19	3.1636E-02
8	2.3502E+19	8.0684E+19	3.7587E-02	28	2.5148E+19	9.0000E+19	4.1045E-02	148	2.0510E+19	7.2428E+19	3.3284E-02
9	2.4875E+19	8.5332E+19	3.9767E-02	29	2.6358E+19	9.4272E+19	4.3006E-02	149	2.1467E+19	7.5780E+19	3.4829E-02
10	2.5600E+19	8.7715E+19	4.0904E-02	30	2.5966E+19	9.6334E+19	4.3972E-02	150	2.1945E+19	7.7392E+19	3.5586E-02
11	2.6007E+19	8.8953E+19	4.1521E-02	31	2.7266E+19	9.7237E+19	4.4424E-02	151	2.2177E+19	7.8090E+19	3.5935E-02
12	2.6090E+19	8.9031E+19	4.1611E-02	32	2.7255E+19	9.6969E+19	4.4357E-02	152	2.2160E+19	7.7864E+19	3.5872E-02
13	2.5728E+19	8.7457E+19	4.0963E-02	33	2.6793E+19	9.4949E+19	4.3524E-02	153	2.1781E+19	7.7864E+19	3.5199E-02
14	2.5079E+19	8.4921E+19	3.9862E-02	34	2.6982E+19	9.2060E+19	4.2289E-02	154	2.1206E+19	7.3960E+19	3.4209E-02
15	2.4118E+19	8.1277E+19	3.8254E-02	35	2.5073E+19	8.8062E+19	4.0560E-02	155	2.0393E+19	7.0792E+19	3.2826E-02
16	2.2857E+19	7.6573E+19	3.6160E-02	36	2.3777E+19	8.3005E+19	3.8356E-02	156	1.9351E+19	6.6788E+19	3.1067E-02
17	2.0848E+19	6.9168E+19	3.2842E-02	37	2.1743E+19	7.5151E+19	3.4914E-02	157	1.7717E+19	6/0572E+19	2.8322E-02
18	1.8969E+19	6.2305E+19	2.9752E-02	38	1.9858E+19	6.7933E+19	3.1737E-02	158	1.6204E+19	5.4859E+19	2.5789E-02
19	1.6854E+19	5.4629E+19	2.6285E-02	39	1.7746E+19	5.9897E+19	2.8189E-02	159	1.4510E+19	4.8498E+19	2.2960E-02
20	1.4530E+19	4.6241E+19	2.2483E-02	40	1.5432E+19	5.1141E+19	2.4311E-02	160	1.2652E+19	4.1563E+19	1.9867E-02

Table 2. Exposure Parameters for Capsule A Charpy Specimens

Specimen Position No.	Fluence >1 MeV	Fluence >.1 MeV	DPA	Specimen Position No.	Fluence >1 MeV	Fluence >.1 MeV	DPA
41	7.6558E+18	2.7335E+19	1.2598E-02	42	7.5128E+18	2.6789E+19	1.2372E-02
43	8.5618E+18	3.0795E+19	1.4133E-02	44	8.4019E+18	3.0179E+19	1.3880E-02
45	9.4528E+18	3.4196E+19	1.5643E-02	46	9.2762E+18	3.3513E+19	1.5362E-02
47	1.0327E+19	3.7534E+19	1.7124E-02	48	1.0134E+19	3.6784E+19	1.6816E-02
49	1.1183E+19	4.0802E+19	1.8574E-02	50	1.0974E+19	3.9987E+19	1.8240E-02
51	1.2019E+19	4.3993E+19	1.9990E-02	52	1.1795E+19	4.3114E+19	1.9631E-02
53	1.2834E+19	4.7102E+19	2.1370E-02	54	1.2594E+19	4.6161E+19	2.0986E-02
55	1.3626E+19	5.0123E+19	2.2711E-02	56	1.3372E+19	4.9122E+19	2.2303E-02
57	1.4394E+19	5.3050E+19	2.4011E-02	58	1.4125E+19	5.1990E+19	2.3580E-02
59	1.5137E+19	5.5878E+19	2.5268E-02	60	1.4854E+19	5.4762E+19	2.4814E-02
61	1.6437E+19	6.0820E+19	2.7465E-02	62	1.6129E+19	5.9605E+19	2.6971E-02
63	1.7100E+19	6.3337E+19	2.8585E-02	64	1.6780E+19	6.2072E+19	2.8071E-02
65	1.7733E+19	6.5736E+19	2.9653E-02	66	1.7401E+19	6.4423E+19	2.9121E-02
67	1.8334E+19	6.8012E+19	3.0667E-02	68	1.7992E+19	6.6654E+19	3.0117E-02
69	1.8903E+19	7.0161E+19	3.1626E-02	70	1.8550E+19	6.8759E+19	3.1058E-02
71	1.9439E+19	7.2178E+19	3.2527E-02	72	1.9076E+19	7.0736E+19	3.1943E-02
73	1.9940E+19	7.4061E+19	3.3370E-02	74	1.9568E+19	7.2581E+19	3.2770E-02
75	2.0406E+19	7.5805E+19	3.4151E-02	76	2.0025E+19	7.4290E+19	3.3538E-02
77	2.0836E+19	7.7407E+19	3.4871E-02	78	2.0447E+19	7.5861E+19	3.4245E-02
79	2.1229E+19	7.8864E+19	3.5527E-02	80	2.0833E+19	7.7289E+19	3.4889E-02
81	2.1860E+19	8.1181E+19	3.6576E-02	82	2.1452E+19	7.9559E+19	3.5919E-02
83	2.2144E+19	8.2210E+19	3.7045E-02	84	2.1730E+19	8.0568E+19	3.6380E-02
85	2.2389E+19	8.3086E+19	3.7447E-02	86	2.1971E+19	8.1426E+19	3.6774E-02
87	2.2594E+19	8.3806E+19	3.7781E-02	88	2.2172E+19	8.2132E+19	3.7102E-02
89	2.2760E+19	8.4569E+19	3.8046E-02	90	2.2334E+19	8.2684E+19	3.7363E-02
91	2.2885E+19	8.4775E+19	3.8242E-02	92	2.2457E+19	8.3081E+19	3.7566E-02
93	2.2969E+19	8.5022E+19	3.8369E-02	94	2.2540E+19	8.3324E+19	3.7680E-02
95	2.3013E+19	8.5110E+19	3.8426E-02	96	2.2583E+19	8.3410E+19	3.7736E-02
97	2.3016E+19	8.5039E+19	3.8414E-02	98	2.2586E+19	8.3340E+19	3.7724E-02
99	2.2979E+19	8.4808E+19	3.8332E-02	100	2.2550E+19	8.3114E+19	3.7643E-02
101	2.2303E+19	8.3967E+19	3.7997E-02	102	2.2377E+19	8.2290E+19	3.7315E-02
103	2.2650E+19	8.3288E+19	3.7718E-02	104	2.2227E+19	8.1624E+19	3.7040E-02
105	2.2458E+19	8.2453E+19	3.7370E-02	106	2.2038E+19	8.0806E+19	3.6699E-02
107	2.2225E+19	8.1463E+19	3.6954E-02	108	2.1810E+19	7.9836E+19	3.6290E-02
109	2.1953E+19	8.0321E+19	3.6471E-02	110	2.1543E+19	7.8717E+19	3.5816E-02
111	2.1643E+19	7.9029E+19	3.5922E-02	112	2.1238E+19	7.7451E+19	3.5277E-02
113	2.1294E+19	7.7589E+19	3.5307E-02	114	2.0896E+19	7.6040E+19	3.4673E-02
115	2.0907E+19	7.6004E+19	3.4629E-02	116	2.0517E+19	7.4486E+19	3.4007E-02
117	2.0484E+19	7.4277E+19	3.3888E-02	118	2.0101E+19	7.2794E+19	3.3279E-02
119	2.0024E+19	7.2411E+19	3.3085E-02	120	1.9650E+19	7.0965E+19	3.2491E-02
121	1.9083E+19	6.8614E+19	3.1446E-02	122	1.8726E+19	6.7243E+19	3.0882E-02
123	1.8524E+19	6.6372E+19	3.0477E-02	124	1.8178E+19	6.5046E+19	2.9930E-02
125	1.7933E+19	6.4007E+19	2.9452E-02	126	1.7598E+19	6.2728E+19	2.8923E-02
127	1.7311E+19	6.1521E+19	2.8374E-02	128	1.6987E+19	6.0292E+19	2.7864E-02
129	1.6657E+19	5.8921E+19	2.7244E-02	130	1.6346E+19	5.7744E+19	2.6755E-02
131	1.5974E+19	5.6210E+19	2.6064E-02	132	1.5676E+19	5.5088E+19	2.5597E-02
133	1.5974E+19	5.3935E+19	2.4838E-02	134	1.4978E+19	5.2328E+19	2.4392E-02
135	1.4525E+19	5.0479E+19	2.3566E-02	136	1.4254E+19	4.9471E+19	2.3143E-02
137	1.3762E+19	4.7469E+19	2.2252E-02	138	1.3505E+19	4.6521E+19	2.1852E-02
139	1.2973E+19	4.4370E+19	2.0897E-02	140	1.2731E+19	4.3484E+19	2.0522E-02

Table 3. Exposure Parameters for Capsule B 1T-CT Specimens

Specimen Position No.	Fluence 1 MeV	Fluence .1 MeV	DPA	Specimen Position No.	Fluence 1 MeV	Fluence .1 MeV	DPA	Specimen Position No.	Fluence 1 MeV	Fluence .1 MeV	DPA
1	5.5006E+18	1.8511E+19	8.7261E-03	21	6.9316E+18	2.4142E+19	1.1131E-02	141	5.6745E+18	1.9113E+19	9.0076E-03
2	7.1566E+18	2.4418E+19	1.1410E-02	22	8.8069E+18	3.0995E+19	1.4212E-02	142	7.1586E+18	2.4395E+19	1.1409E-02
3	8.7272E+18	3.0017E+19	1.3955E-02	23	1.0579E+19	3.7464E+19	1.7121E-02	143	8.5609E+18	2.9382E+19	1.3677E-02
4	1.0194E+19	3.5238E+19	1.6330E-02	24	1.2226E+19	4.3471E+19	1.9824E-02	144	9.8654E+18	3.4015E+19	1.5785E-02
5	1.1879E+19	4.1222E+19	1.9055E-02	25	1.4109E+19	5.0315E+19	2.2909E-02	145	1.1358E+19	3.9299E+19	1.8193E-02
6	1.3047E+19	4.5350E+19	2.0939E-02	26	1.5405E+19	5.5005E+19	2.5028E-02	146	1.2387E+19	4.2925E+19	1.8193E-02
7	1.4060E+19	4.8907E+19	2.2567E-02	27	1.6521E+19	5.9014E+19	2.6844E-02	147	1.3275E+19	4.6033E+19	2.1273E-02
8	1.4905E+19	5.1849E+19	2.3919E-02	28	1.7442E+19	6.2294E+19	2.8338E-02	148	1.4011E+19	4.8584E+19	2.2448E-02
9	1.5724E+19	5.4649E+19	2.5219E-02	29	1.8318E+19	6.5355E+19	2.9745E-02	149	1.4717E+19	5.0984E+19	2.3565E-02
10	1.6153E+19	5.6064E+19	2.5888E-02	30	1.8760E+19	6.6839E+19	3.0442E-02	150	1.5079E+19	5.2166E+19	2.4127E-02
11	1.6390E+19	5.6773E+19	2.6242E-02	31	1.8982E+19	6.7495E+19	3.0772E-02	151	1.5270E+19	5.2717E+19	2.4407E-02
12	1.6432E+19	5.6768E+19	2.6275E-02	32	1.8982E+19	6.7318E+19	3.0731E-02	152	1.5285E+19	5.2632E+19	2.4401E-02
13	1.6203E+19	5.5731E+19	2.5854E-02	33	1.8659E+19	6.5894E+19	3.0146E-02	153	1.5054E+19	5.1608E+19	2.3983E-02
14	1.5803E+19	5.4117E+19	2.5164E-02	34	1.8156E+19	6.3846E+19	2.9272E-02	154	1.4676E+19	5.0092E+19	2.3334E-02
15	1.5215E+19	5.1822E+19	2.4167E-02	35	1.7440E+19	6.1009E+19	2.8045E-02	155	1.4131E+19	4.7971E+19	2.2413E-02
16	1.4445E+19	4.8874E+19	2.2875E-02	36	1.6518E+19	5.7418E+19	2.6481E-02	156	1.3424E+19	4.5270E+19	2.1229E-02
17	1.3221E+19	4.4249E+19	2.0833E-02	37	1.5070E+19	5.1839E+19	2.4036E-02	157	1.2307E+19	4.1057E+19	1.9369E-02
18	1.2077E+19	3.9969E+19	1.8934E-02	38	1.3727E+19	4.6714E+19	2.1780E-02	158	1.1266E+19	3.7172E+19	1.7646E-02
19	1.0789E+19	3.5187E+19	1.6805E-02	39	1.2223E+19	4.1011E+19	1.9262E-02	159	1.0097E+19	3.2838E+19	1.5716E-02
20	9.3728E+18	2.9962E+19	1.4470E-02	40	1.0575E+19	3.4801E+19	1.6512E-02	160	8.8122E+18	2.8107E+19	1.3603E-02

Table 4. Exposure Parameters for Capsule B Charpy Specimens

SPECIMEN POSITION No.	FLUENCE >1 MeV	FLUENCE >.1 MeV	DPA	SPECIMEN POSITION No.	FLUENCE >1 MeV	FLUENCE >.1 MeV	DPA
41	5.5840E+18	1.9859E+19	9.1671E-03	42	5.4686E+18	1.9381E+19	8.9778E-03
43	6.2505E+18	2.2376E+19	1.0289E-02	44	6.1213E+18	2.1838E+19	1.0076E-02
45	6.9059E+18	2.4851E+19	1.1392E-02	46	6.7631E+18	2.4253E+19	1.1157E-02
47	7.5491E+18	2.7280E+19	1.2474E-02	48	7.3931E+18	2.6623E+19	1.2217E-02
49	8.1790E+18	2.9657E+19	1.3534E-02	50	8.0100E+18	2.8944E+19	1.3254E-02
51	8.7945E+18	3.1980E+19	1.4569E-02	52	8.6127E+18	3.1210E+19	1.4268E-02
53	9.3945E+18	3.4242E+19	1.5578E-02	54	9.2002E+18	3.3419E+19	1.5256E-02
55	9.9778E+18	3.6441E+19	1.6559E-02	56	9.7715E+18	3.5564E+19	1.6217E-02
57	1.0544E+19	3.8571E+19	1.7509E-02	58	1.0326E+19	3.7644E+19	1.7148E-02
59	1.1091E+19	4.0630E+19	1.8428E-02	60	1.0861E+19	3.9652E+19	1.8048E-02
61	1.2049E+19	4.4228E+19	2.0036E-02	62	1.1799E+19	4.3164E+19	1.9622E-02
63	1.2538E+19	4.6060E+19	2.0855E-02	64	1.2278E+19	4.4952E+19	2.0425E-02
65	1.3004E+19	4.7807E+19	2.1637E-02	66	1.2736E+19	4.6657E+19	2.1191E-02
67	1.3448E+19	4.9464E+19	2.2380E-02	68	1.3170E+19	4.8274E+19	2.1918E-02
69	1.3868E+19	5.1029E+19	2.3082E-02	70	1.3582E+19	4.9802E+19	2.2606E-02
71	1.4264E+19	5.2499E+19	2.3743E-02	72	1.3969E+19	5.1236E+19	2.3252E-02
73	1.4635E+19	5.3870E+19	2.4360E-02	74	1.4332E+19	5.2574E+19	2.3857E-02
75	1.4979E+19	5.5141E+19	2.4933E-02	76	1.4670E+19	5.3815E+19	2.4418E-02
77	1.5297E+19	5.6309E+19	2.5461E-02	78	1.4981E+19	5.4954E+19	2.4935E-02
79	1.5589E+19	5.7371E+19	2.5943E-02	80	1.5266E+19	5.5991E+19	2.5407E-02
81	1.6057E+19	5.9061E+19	2.6714E-02	82	1.5725E+19	5.7641E+19	2.6162E-02
83	1.6258E+19	5.9813E+19	2.7059E-02	84	1.5932E+19	5.8374E+19	2.6500E-02
85	1.6451E+19	6.0452E+19	2.7355E-02	86	1.6110E+19	5.8998E+19	2.6791E-02
87	1.6604E+19	6.0979E+19	2.7602E-02	88	1.6261E+19	5.9512E+19	2.7032E-02
89	1.6728E+19	6.1392E+19	2.7799E-02	90	1.6382E+19	5.9915E+19	2.7225E-02
91	1.6823E+19	6.1690E+19	2.7945E-02	92	1.6475E+19	6.0206E+19	2.7368E-02
93	1.6888E+19	6.1873E+19	2.8041E-02	94	1.6539E+19	6.0384E+19	2.7462E-02
95	1.6923E+19	6.1940E+19	2.8086E-02	96	1.6573E+19	6.0450E+19	2.7506E-02
97	1.6928E+19	6.1891E+19	2.8080E-02	98	1.6578E+19	6.0402E+19	2.7501E-02
99	1.6904E+19	6.1727E+19	2.8024E-02	100	1.6554E+19	6.0242E+19	2.7445E-02
101	1.6780E+19	6.1121E+19	2.7785E-02	102	1.6433E+19	5.9551E+19	2.7212E-02
103	1.6671E+19	6.0630E+19	2.7585E-02	104	1.6326E+19	5.9171E+19	2.7015E-02
105	1.6532E+19	6.0026E+19	2.7334E-02	106	1.6190E+19	5.8582E+19	2.6770E-02
107	1.6364E+19	5.9309E+19	2.7034E-02	108	1.6026E+19	5.7883E+19	2.6476E-02
109	1.6168E+19	5.8482E+19	2.6685E-02	110	1.5833E+19	5.7075E+19	2.6.34E-02
111	1.5942E+19	5.7545E+19	2.6287E-02	112	1.5613E+19	5.6161E+19	2.5744E-02
113	1.5689E+19	5.6501E+19	2.5842E-02	114	1.5365E+19	5.5142E+19	2.5308E-02
115	1.5408E+19	5.5352E+19	2.5350E-02	116	1.5089E+19	5.4020E+19	2.4826E-02
117	1.5099E+19	5.4099E+19	2.4812E-02	118	1.4787E+19	5.2797E+19	2.4300E-02
119	1.4764E+19	5.2745E+19	2.4229E-02	120	1.4459E+19	5.1476E+19	2.3729E-02
121	1.4078E+19	4.9988E+19	2.3039E-02	122	1.3787E+19	4.7875E+19	2.2563E-02
123	1.3671E+19	4.8361E+19	2.2334E-02	124	1.3388E+19	4.7197E+19	2.1873E-02
125	1.3239E+19	4.6643E+19	2.1588E-02	126	1.2965E+19	4.5521E+19	2.1143E-02
127	1.2784E+19	4.4838E+19	2.0804E-02	128	1.2520E+19	4.3759E+19	2.0374E-02
129	1.2307E+19	4.2949E+19	1.9982E-02	130	1.2052E+19	4.1916E+19	1.9559E-02
131	1.1807E+19	4.0980E+19	1.9124E-02	132	1.1563E+19	3.9995E+19	1.8729E-02
133	1.1287E+19	3.8935E+19	1.8231E-02	134	1.1054E+19	3.7998E+19	1.7854E-02
135	1.0747E+19	3.6817E+19	1.7305E-02	136	1.0525E+19	3.5931E+19	1.6947E-02
137	1.0188E+19	3.4630E+19	1.6347E-02	138	9.9775E+18	3.3797E+19	1.6010E-02
139	9.6111E+18	3.2378E+19	1.5360E-02	140	9.4124E+18	3.1599E+19	1.5043E-02

values. Preliminary results of the uncertainty analysis can be found in Ref. 7.

3. Conclusions and Recommendations

The results achieved in the analysis of the fourth HSST experiments indicate that for a reasonable amount of time and funds, a considerable improvement in accuracy is attainable. The following steps are suggested for the analysis of exposure parameters from test reactor experiments.

1. ^{237}Np (n,f) and ^{238}U (n,f) sensors with gadolinium or CdO covers be included in the dosimetry multiple foil sets at select locations.
2. Single wire sensors should be placed at as many locations as feasible to obtain a complete and accurate spatial distribution of fast fluxes.
3. Good calculations for the source term in the core and the transport of neutrons from the core to the experiment.
4. A cross section data base for the reaction rate cross section and their variances and covariances.
5. A least square adjustment method to combine the reaction rate data, the calculated fluxes, and cross section values and arrive at an overall uncertainty for the exposure parameter of interest.

REFERENCES

1. F. W. Stallmann, "LSL, A Logarithmic Least Squares Adjustment Method," Proceedings of the Fourth ASTM-EURATOM Symposium on Reactor Dosimetry (to be published).
2. F. J. Witt, "The USAEC Heavy Section Steel Technology Program: Objectives and Status," Nucl. Eng. Des. 20(1), pp. 169-180 (June 1972).
3. G. D. Whitman and R. H. Bryan, Heavy-Section Steel Technology Program Quarterly Progress Report for Jan.-Mar. 1981, NUREG/CR-2141/VI, ORNL/TM-7822 (June 1981).
4. F. W. Stallmann and F. B. K. Kam, Neutron Spectral Characterization of the Second Nuclear Regulatory Commission Heavy Section Steel Technology 4T-CT Irradiation Experiment, ORNL/NUREG/TM-285 (Dec. 1978).
5. F. W. Stallmann and F. B. K. Kam, "Neutron Spectral Characterization of the NRC-HSST Experiments," Proceedings of the Third ASTM-EURATOM Symposium on Reactor Dosimetry, EUR 5667, Vol. 1, pp. 198-207 (1980).

6. W. N. McElroy (Editor), LWR Pressure Vessel Surveillance Dosimetry Improvement Program: PCA Experiments and Blind Test, NUREG/CR-1861 (July 1981).
7. F. W. Stallmann, "Uncertainties in the Estimation of Radiation Damage Parameters," Proceedings of the Fourth ASTM-EURATOM Symposium on Reactor Dosimetry (to be published).